SECTION 91

MOTORS, CONTROLLERS AND CONTROL EQUIPMENT

91.1 REFERENCES

(91A) Code of Federal Regulations - 46 CFR Sub-chapter J

(91B) Code of Federal Regulations - 46 CFR Sub-chapter H

(91C) INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, Standard IEEE-45

(91D) UNDERWRITERS LABORATORIES - Standard UL-508, and UL845

(91E) INTERNATIONAL ELECTRO-TECHNICAL COMMISSION (IEC) STANDARDS, Standard 92

(91F) AMERICAN BUREAU OF SHIPPING (ABS), *Rules for Steel Vessels*

(91G) NEMA Standard ICS-2

91.2 INTRODUCTION

This Section contains the Contractor Design and Provide general requirements for electric motors, motor controllers, motor starters, master switches and motor controller pilot devices.

For WSF Fleet-wide Standardization purposes, End No. 1 of the Vessel shall always be considered the bow, and this designation shall delineate port and starboard, fore and aft wherever they are addressed in the Technical Specification.

91.3 GENERAL

The electric motors and associated equipment shall meet the design, performance, application and installation requirements defined herein, while meeting the applicable rules and regulations listed elsewhere.

All watertight electrical equipment, including motors, brakes, controllers, limit switches and master switches, shall be provided with drainage devices installed at the lowest point of enclosure. Motors and control enclosures located to weather shall be fitted with heaters to preclude condensation and ensure operation in down to a minus twenty (-20)F degrees ambient temperature.

Where practicable, motor controllers shall be installed within grouped Motor Control Centers (MCCs) installed in the Engine Rooms, Reduction Gear Rooms, and Fan Rooms in lieu of individual controllers.

Motor controllers shall not be installed on the Vehicle Decks.

Motor control wiring diagrams shall be placed on the interior of all controls. These shall indicate remote control devices also.

See Sections 51 and 52 of the Technical Specification for additional MCC requirements.

See Section 87, of the Technical Specification for other requirements, for installation and construction.

91.4 MOTORS

Generally, motors of ¾-horsepower and larger shall be suitable for operation on 480 Vac, 3-phase circuits. Single-phase motors, where employed, shall be high starting torque and shall operate satisfactorily on 120 Vac, 60 Hz power. Three-phase motors shall be NEMA Design “B” unless the characteristic of the driven machine requires otherwise.

Motors shall be installed in locations high enough to avoid bilge water. Motors located below decks are to be installed in dry locations and as far as practical from steam, water and oil piping.

Motors located in machinery spaces shall be TEFC, and shall provide a minimum IP 44 degree of protection.

Motors for Pumps are to have the drive end entirely enclosed or designed to prevent leakage from entering the motor.

Motors exposed on weather decks are to provide an IP 56 degree of protection.

Motors shall be from one manufacturer wherever possible to minimize necessary spares.

All motors shall be equipped with pre-lubricated factory-sealed bearings of suitable design to take the required thrust and radial loads. The motors shall be equipped so that in-service greasing will not be necessary except during manufacturer's recommended overhaul periods.

Motors in damp locations such as the weather decks and unheated areas shall have the windings encapsulated in epoxy resins.

91.5 MOTOR CONTROLLERS

Individual Motor Controllers and Motor Controllers used in Motor Control Centers (MCC) shall have the same characteristics and shall be a manufactured solution providing a uniform system of assembly within a family of system components.

Motor Controllers shall be rated for at least the maximum short circuit current available.

Individual motor controllers are to be located and placed or protected to minimize the probability of mechanical injury or damage.

The design and arrangement of the motor controllers shall provide accessibility to parts requiring inspection and adjustment.

Three-phase motor circuits 480 Vac or less shall not use fused elements for line side protection.

For all motor controllers an individual circuit is to be provided for each fixed motor and the conductors are to be sized to not less than 125-percent (≥125%) of the motors full load current capacity.

Motor controllers having a working power rating of 0.5kW or greater shall provide suitable motor protection which is adjustable and set between 100% and 125% of the motors rated current.

Motor controllers having a working power rating of 0.5kW or greater shall typically provide Low Voltage Protection (LVP) to avoid excess starting currents when power is lost then re-established on the Vessel.

Low Voltage Release (LVR) shall be employed on motor controllers vital to the operation of the Vessel’s propulsion and other systems required by regulation.

All electrical components shall be suitable for voltage and frequency variations in the Vessel's power supply.

The components shall be able to sustain service through a voltage variation of +6% to –10% permanent variation, and a ±20% transient variation for duration of 1.5 seconds.

The components shall be suitable for frequency variations to sustain service with a ±5% permanent variation in frequency and ±10% for 5 seconds for transient variations.

Three (3) types of motor control systems shall be employed in the New 144-Auto Ferries construction and are listed as follows:

1. Manual Motor Controllers.

2. Combination Electro-mechanical Motor Controllers for non-reversing and reversing applications.

3. Variable Speed or two (2) speed Motor Controllers and Variable Frequency Drives.

91.5.1 Manual Motor Controllers

Controllers for single speed non-reversing motors of less than ¾ horsepower may be of the manual across-the-line IEC or NEMA style manual motor control.

91.5.2 Combination Electro-mechanical Motor Controllers for non-reversing and reversing applications

Controllers for all other motors, except those mentioned below, shall be of the IEC or NEMA style magnetic across-the-line type unless momentary voltage drop conditions require a current limiting type starter. All IEC magnetic controllers shall be rated by kW and sized a minimum of two (2) times the full load current of the motor which the device is controlling.

Larger combination type IEC controllers shall be sized two (2) times the horsepower rating of the motor. All motor control devices and accessories shall be fabricated or constructed by one (1) manufacturer.

91.5.3 Variable Speed or Two (2) Speed Motor Controllers and Variable Frequency Drives

Variable-speed motor controllers shall be designed to meet the requirement of the system load. All variable-speed controllers shall be supplied with line filtering and choke circuits to minimize the effects of harmonic interference. Alternatives to non-linear, solid state device variable-speed drives, such as Magna-Drive, shall be considered during design development.

91.5.4 Stand Alone Motor Controllers

The type of enclosure required for the protection of the motor controller shall be suitable for the intended location.

Controller enclosures exposed to the weather, dampness or corrosive environments shall be made of stainless steel with stainless steel hardware. Filters shall be provided in the air intake where panels are force ventilated. Controllers installed in interior locations shall have, at a minimum, drip-proof enclosures.

Individual Motor controllers shall have all pushbuttons, switches and indicator lights required for operation mounted on the face of the controller. All motor controller indication lights shall provide an integral “Push-to-Test” circuit.

Remote operating stations shall be provided where control from more than one (1) location is required. Where no visual indication of equipment operation exists, the controller shall be provided with the necessary fused circuits for energizing “power on” indicating lights.

Where the driven equipment is not within sight of the motor controller or is separated by more than ten (10) linear feet, a master switch type remote control shall be provided adjacent to the driven equipment.

Motor controllers shall provide a disconnect device equipped and provisioned for a lockout mechanism in the open position. If the disconnect device is not within sight of both motor and controller, or located 15.25M (>50') from either then a separate disconnect device shall be provided at the motor. The disconnect device, if not adjacent to the controller, shall be provided with an identification plate.

There shall be a visible indication by position of the handle whether the disconnect device is in the open or closed position.

Magnetic controllers that operate from a remote (automatic) two-wire pilot device (pressure switches, etc.) shall be provided with the additional relay necessary to provide for low voltage protection. They shall also be provided with a local manual 3-position selector switch for “HAND”, “OFF” and “AUTOMATIC” operation. Generally, the local selector switch shall be arranged to maintain any of the three (3) positions selected. When local control is selected, the wiring for remote controls and associated lights shall be completely disconnected from the control circuit without affecting operation from the control enclosure.

Stand alone motor controllers shall function as electrically operated, three-phase power switches that, when coupled with appropriate overload relays, function as full-voltage non-reversing motor starters.

Functionally, overload shall be provided in all three-phases and provide phase loss protection. IEC starters shall provide integral timers, interlocks, and Under Voltage (UV) trips as required by the specification requirements. External coils used in conjunction and interlocking with the motor controllers shall provide the means to operate the coil mechanically.

The power line and load lug connection of the power devices shall be labeled.

Contactors shall be provided as many auxiliary contacts as required for each control system.

A manufacturer's label affixed to each contactor, shall clearly show the horsepower and kilowatt ratings of the device and the UL, CSA and other appropriate listing marks. This label shall be permanent and the marking shall neither fade nor otherwise become illegible.

The overload relay shall have an auxiliary contact of a normally open form and a normally-closed contact to be wired in series with the contactor coil. A method to test the overload relay by manually causing it to trip shall be provided and confirmation of contact trip shall be visible. The manual trip mechanism shall be accessible without disassembling any components, but protected from accidental actuation.

In accordance with IEC design standards, all electrical current carrying parts (terminals, screws, etc.) shall be recessed in the overload relay's housing to provide total finger and back-of-hand protection to reduce or eliminate the risk of accidental shock.

Overload relays shall be available as manual resets.

Motor controllers shall provide individual stand-alone step down Control Power Transformers (CPT) rated at 460-120 Vac and 100VA.

The CPT's 460 Vac primary line side interrupts shall be rejection style cartridges.

The CPT's 120 Vac Secondary interrupts shall provide blown fuse indication.

91.5.5 Motor Control Centers

Motor Control Centers (MCC) shall provide electrical services to motor driven rotating machinery operating on 3-phase, three wire ungrounded circuits supplied with a nominal voltage of 480 Vac at 60 Hz.

The MCCs shall be constructed to safely allow troubleshooting and repair of one (1) motor controller while all other motor controllers in the MCC remain energized.

Each MCC branch circuit motor and motor control system shall provide stand-alone functionality.

Motor Controllers and equipment shall be designed to meet the following specifications:

1. Rated for continuous duty at 480 Vac 3-phase, 3-wire system operating at 60Hz.
2. Rated for 400 Amp.
3. Working components rated and components braced at not less than 38kAIC.
4. Accept mounting of MCP type circuit breakers, IEC or NEMA starters, and fuses.
5. Silver-plated copper bus bars, E-Cu 57 copper.
6. Bus bar holders shall be fiberglass-reinforced, thermoplastic polyester (PBT).

Motor Control Centers are to be designed, constructed and tested in accordance with the Technical Specification and the rules and guidelines set forth , but not limited to References (91A) through (91G).

Motor Control Centers shall be designed to meet all specific motor systems requirements and shall be constructed to the appropriate UL Standards by an OSHA Approved Nationally Recognized Testing Laboratory (NRTL) certified manufacture.

All operator interface switches and indicator lights on the MCC front panels shall be 22 mm type. Indicator lights shall indicate “POWER AVAILABLE”, “RUN”, “AUTO”, “LOW SPEED”, and “HIGH SPEED” as appropriate. Indicator lamps shall be light emitting diode (LED) cluster type.

Unless otherwise noted each MCC section shall be designed and constructed as a free standing unit with provisions to bolt the MCC to a foundation, and where required “bay”, with other MCC equipment or Switchgear.

The equipment shall be designed and constructed to protect the motor controls from physical contact, mechanical damage, and contamination or contact of working components with dust or liquids.

Each MCC shall be constructed to meet the degree of protection suitable for the intended location. The equipment shall be designed and constructed to provide a “dead front” degree of construction.

The manufacturer’s construction practices shall maintain proper distances between live parts, of different potentials, and structural metal components. Insulating materials are to be suitable for the working potentials of the MCC.

Front access for all serviceable components shall be required. Service access from the rear shall be limited to maintenance of bus connections, circuit breaker stab connections to field loads and making up ship’s cable and shipping splits on installation as applicable.

Each MCC section shall be provided with an individual multi-cable transit (MCT) located on the top or bottom of the enclosure and with provisions for cable entry into the bottom of the enclosure-mounting base. Each MCT shall be sized to the service requirements of each MCC.

The top mounted MCT shall mount integral with a continuous drip shield providing flange mounting and liquid tight gasket.

The MCC framework is to be constructed of code gage steel, welded together providing the mechanical load bearing structure and support of skins, compartmental divider plates, cover plates, bracing, bussing and component devices. All closure plates shall be fabricated from code gauge steel and shall have formed edges.

MCC cabinets shall be prepared for powder coating as set forth in Section 14 of the Technical Specification. Finish shall be "METER GRAY" (ANSI No. 49) powder coat.

Construction materials should be selected for marine application with consideration to reduce the degree of dissimilar metals that may come in contact with each other.

The MCC door shall be hinged and provide a "door stop" to secure and lock the door in an open position for service purposes.

The MCC section shall be provided with an integral handrail. The handrail shall be provided with an insulating, horizontal hand grab mounted to the door with counter-sunk thru bolted finished metal brackets.

Motor Control Centers shall provide a means of disconnecting and locking out individual motor circuits at the Motor Control Center. The disconnect device is to indicate whether the device is open or closed.

The MCCs shall be equipped to provide up to 20-percent (20%) future expansion of motor controllers sized between 1-hp to 60-hp.

Including all general requirements the MCCs shall meet the following additional requirements:

1. System bus and lug connections shall provide a dead front cover and be clearly marked and labeled to designate voltage and shock hazard.

2. The MCC shall be designed to meet fire protection and flame retardation as specified in IEC 92-101 and UL 94.

3. The MCC and related components shall be designed, constructed, and installed to meet IEC 68-2-6 vibration and physical shock criteria.

4. The MCC shall meet or exceed the environmental criteria as set forth in IEC 68-2-1, 2, 30, and 52.

5. All MCC components shall provide electric shock protection/finger safe protection to meet or exceed IEC 60 529/DIN VDE 0470-1.

6. The MCCs shall be clearly labeled for internal and external mounted equipment.

7. All hook-up wire, cable, and floaters shall be constructed to meet zero (0) halogen requirements to the extent practicable.

8. The MCC shall provide copper bus bars, rated and sized to accommodate up to 20-percent (20%) future expansion. The Bus shall provide suitable connections for the line side feeders and all provisions for future expansion.

9. The bus connections shall be bolted to the MCC bus bar and held captive with BELLEVILLE, or equal, washer/nyloc nut-bolt combination. All connection points shall use an anti corrosion-inhibiting compound suitable for the installation.

10. The MCC section shall provide a copper isolated grounding bus bar equal to the ampacity of the current carrying bus bars.

11. The MCC shall provide molded case circuit breakers and integrated IEC or NEMA motor controllers.

12. Molded case circuit breakers shall provide plug base-front draw out installation without disconnection of power, with digital solid state, ambient insensitive tripping (overloads).

13. Circuit breakers and Motor Controller Protectors (MCP) shall be arranged and mounted such that the means of disconnect is extended thru and can be operated thru the MCC door. The MCC shall provide a thru panel operator or cutout as applicable.

14. Molded case circuit breakers shall have over-center, toggle handles arranged for thru door toggle handle operation. The design shall provide common tripping of all poles.

15. The escutcheon area of the breaker cover shall have molded-in “ON” and “OFF” markings and corresponding “I” and “O” (for “ON” and “OFF” respectively) international markings.

16. Where required, instantaneous-only breakers shall be MAG Break® or MAG Guard® style motor circuit protectors, or equal.

17. Internal accessories shall be UL listed for field installation and shall not require circuit breaker cover removal.

18. Controllers for single speed non-reversing motors of less than ¾hp may be manual across the line controls.

19. Controllers for all other motors shall function as electrically operated, three-phase power switches that, when coupled with appropriate overload relays, function as full-voltage non-reversing motor starters.

20. Functionally, overload shall be provided in all three phases and provide phase loss protection. IEC starters shall provide integral timers, interlocks, and UV trips as required by the specification requirements. External coils used in conjunction and interlocking with the motor controllers shall provide the means to operate the coil mechanically.

21. The power line and load lug connection of the power devices shall be labeled.

22. Contactors shall be provided as many auxiliary contacts as required for control, alarm and monitoring.

23. A manufacturer's label affixed to each contactor, shall clearly show the horsepower and kilowatt ratings of the device and the UL, CSA and other appropriate listing marks. This label shall be permanent and the marking shall neither fade nor otherwise become illegible.

24. The overload relay shall have an auxiliary contact of a normally open form and a normally closed contact to be wired in series with the contactor coil. A method to test the overload relay by manually causing it to trip shall be provided and confirmation of contact trip shall be visible. The manual trip mechanism shall be accessible without disassembling any components but protected from accidental actuation.

25. In accordance with IEC design standards, all electrical current carrying parts (terminals, screws, etc.) shall be recessed in the overload relay's housing to provide total finger and back-of-hand protection to reduce or eliminate the risk of accidental shock.

26. Overload relays shall be available as manual resets.

27. Motor controllers shall provide individual stand-alone step down Control Power Transformers (CPT) rated at 460-120 Vac and 100VA.

28. The CPT's 460 Vac primary line side interrupts shall be rejection style cartridges.

29. The CPT's 120 Vac Secondary interrupts shall provide blown fuse indication.

30. Pilot devices and operators shall be logically arranged and physically located respective to each motor circuit protector toggle that is physically connected to

the motor load that the pilots and operators control. Each motor controller shall include all necessary pilot devices and control elements to provide the proper operational functionality located on the motor controller. Remote operating stations shall be provided where control from more than one location is required.

31. Provide REDLION Model C48T, or equal, Dual Preset digital LED hour meters on the front of the following motor controllers: ***1).*** Stern Tube Pump Nos. 1, 2, 3, and 4, ***2).*** CPP Servo Pump Nos. 1, 2 ,3, and 4, ***3).*** Standby Electric Reduction Gear Pump No.s 1 and 2, ***4).*** Air Compressor No.s 1 and 2, ***5).*** Steering Gear Pump Nos. 1, 2, 3, and 4.

91.5.6 Installation Requirements

Delivery of the MCC sections shall be coordinated with the construction schedule of the Vessel.

The MCCs shall be designed and constructed as freestanding units with provisions to bolt and anchor the MCCs to a welded foundation and "bay" to the switchgear shipping splits as required.

The manufacturer shall provide the MCCs mounted to a temporary shipping plinth constructed to be used as a lifting base. The base should be designed as a load-bearing element with integral picking points to shackle cables and intended for use with an overhead crane. Additionally, the temporary base shall be constructed for moving the equipment with the use of a forklift.

The lifting base shall be used one time to move the equipment into place on the Vessel at the Shipyard. The base shall be easy to remove once the equipment is located in place on the Vessel.

The MCCs shall be designed, constructed, and provided with appropriate shipping splits to suit the Contractor's detailed design.

Shipping splits shall be packed and crated for weatherproofing the equipment and desiccant packs shall be installed inside the electrical equipment.

All crates shall be properly labeled to identify the equipment inside.

91.6 SPARE PARTS AND INSTRUCTION MANUALS

Provide a list of recommended spare parts and special tools, for those items which are Contractor furnished, together with parts lists and instruction manuals necessary to maintain and service provided equipment and accessories in accordance with the requirements of Sections 86 and 100 of the Technical Specification.

91.7 TESTS, TRIALS, AND INSPECTIONS

Tests and/or Trials shall be in accordance with Section 101 of the Technical Specification.

Inspections shall be performed as defined in this Section and in Sections 1 and 2 of the Technical Specification.

91.8 PHASE II TECHNICAL PROPOSAL REQUIREMENTS

See Section 100 of the Technical Specification for requirements regarding technical documentation.

91.9 PHASE III DETAIL DESIGN AND CONSTRUCTION REQUIREMENTS

The following deliverable, in addition to other documentation or drawings required by Section 100 of this Technical Specification and the Authoritative Agencies, shall be provided during the Phase III Detail Design stage of Work in accordance with the requirements of Section 100 of the Technical Specification:

A. List of Motors and Controllers

See Section 100 of the Technical Specification for additional requirements regarding technical documentation.

(END OF SECTION)